

**Claims**

1. A multi-layer microwave resonator, comprising:

a cavity having an inner surface formed from an electrically conductive material;

- 5 a plurality of pieces of dielectric materials stacked on top of each other to form a contiguous body, the body being provided in the cavity;

wherein the dielectric materials of the pieces are chosen such that the dielectric constant of the pieces alternate between a relatively high dielectric constant and a relatively low dielectric constant.

- 10 2. A resonator as claimed in claim 1, wherein the dielectric materials of the pieces are chosen such that the thermal coefficient of dielectric constant of the pieces alternate between a positive thermal coefficient of dielectric constant and a negative thermal coefficient of dielectric constant.

- 15 3. A resonator as claimed in claim 1 or 2, wherein the body includes a central piece of dielectric material having a relatively low dielectric constant.

4. A resonator as claimed in claim 3, wherein the central piece has a length substantially commensurate with an integer multiple of one-half wavelength of a desired operating frequency in the dielectric material.

5. A resonator as claimed in claim 1, wherein:

- 20 the body is formed of three pieces of dielectric materials, arranged as a central piece of a first dielectric material and two end pieces of a second dielectric material, the central piece being provided between the two end pieces;

the central piece of dielectric material having a length substantially commensurate with an integer multiple of one-half wavelength of a desired operating frequency in said first dielectric material;

5 each end piece having a length substantially commensurate with an odd integer multiple of one-half wavelength of the desired operating frequency in the second dielectric material;

the dielectric constant of the second dielectric material being greater than the dielectric constant of the first dielectric material.

6. A resonator as claimed in claim 5, further comprising:

10 an even plurality of intermediate pieces of dielectric materials provided between the central piece and each end piece;

each intermediate piece being formed from either the first dielectric material or the second dielectric material;

15 each intermediate piece having a length substantially commensurate with an odd integer multiple of one-quarter wavelength of the desired operating frequency in whichever of the first or second dielectric material the intermediate piece is formed from;

20 the intermediate pieces provided between the central piece and each end piece comprise an equal number of intermediate pieces formed from the first dielectric material and intermediate pieces formed from the second dielectric material;

25 the intermediate pieces being arranged such that the pieces of dielectric materials forming the body alternate between pieces formed from the second dielectric material and pieces formed from the first dielectric material.

7. A resonator as claimed in claim 1, wherein:

5 the body is formed of five pieces of dielectric materials, arranged as a central piece of a first dielectric material, two intermediate pieces of a second dielectric material and two end pieces of the first dielectric material, the central piece being provided between the two intermediate pieces, the central piece and the intermediate pieces being provided between the two end pieces;

the central piece of dielectric material having a length substantially commensurate with an integer multiple of one-half wavelength of a desired operating frequency in said first dielectric material;

10 each intermediate piece having a length substantially commensurate with an odd integer multiple of one-quarter wavelength of the desired operating frequency in the second dielectric material;

each end piece having a length substantially commensurate with an odd integer multiple of one-quarter wavelength of the desired operating frequency in the first dielectric material;

15 the dielectric constant of the second dielectric material being greater than the dielectric constant of the first dielectric material.

8. A resonator as claimed in claim 7, wherein:

20 an odd plurality of intermediate pieces of dielectric materials are provided between the central piece and each end piece;

each intermediate piece being formed from either the first dielectric material or the second dielectric material;

25 each intermediate piece having a length substantially commensurate with an odd integer multiple of one-quarter wavelength of the desired operating frequency in whichever of the first or second dielectric material said intermediate piece is formed from;

the intermediate pieces provided between the central piece and each end piece comprise alternate between an intermediate piece formed from the second dielectric material and an intermediate piece formed from the first dielectric material;

5 the intermediate pieces being arranged such that the pieces of dielectric materials forming the body alternate between pieces formed from the first dielectric material and pieces formed from the second dielectric material.

9. A resonator as claimed in any one of claims 6 to 8, wherein each intermediate  
10 piece formed from the second dielectric material has an aperture formed centrally therein.

10. A resonator as claimed in any one of claims 6 to 9, wherein each intermediate piece formed from the first dielectric material has an aperture formed centrally therein.

15 11. A resonator as claimed in any one of claims 6 to 10, wherein the central piece has an aperture formed centrally therein.

12. A resonator as claimed in any one of claims 6 to 11, wherein each end piece formed has an aperture formed centrally therein.

13. A resonator as claimed in any one of claims 3 to 12, wherein the central piece  
20 has an opening formed therein for receiving test substances.

14. A resonator as claimed in any one of the preceding claims, wherein the first dielectric material is sapphire.

15. A resonator as claimed in any one of the preceding claims, wherein the second dielectric material is rutile.

25 16. A resonator as claimed in any one of the preceding claims, wherein the pieces of dielectric material are substantially cylindrical.

17. A resonator as claimed in any one of the preceding claims, wherein the cavity comprises a cylindrical wall and two ends, the body being contained between the ends of the cavity.

5 18. A resonator as claimed in claim 17, wherein the cylindrical wall is spaced from the body.

19. A resonator as claimed in claim 17, wherein the cylindrical wall abuts the body.